Gender in Domestic Programming: from *Bricolage* to *Séances d'Essayage*

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ABSTRACT
Developments in ubiquitous computing mean that domestic appliances are increasingly programmable, providing new opportunities for end-user control and configuration. Unfortunately home programming, just as with end-user programming in professional contexts, is associated with stereotypically masculine learning styles. This is likely to result in future inequalities surrounding domestic technology. This paper summarises recent experimental evidence regarding the role of self-efficacy in learning through experimentation, demonstrates that similar gender-linked behaviour can be found in both domestic and professional contexts, and recommends a new approach to promoting such experimentation among women.

INTRODUCTION

In North America and the United Kingdom, computer programming has strong gender-specific connotations. Most professors of computer science are male, the computing "high culture" of hacking is overtly masculine [8], and universities (including my own) have great difficulty persuading female applicants to apply to study computer disciplines.

Do these patterns have any broader consequences, beyond a gender imbalance in the computing professions? In previous work, I have related the cognitive demands of computer programming, as practiced professionally, to the practice of programming on a smaller scale in order to control and configure domestic appliances [4]. Ubiquitous computing technologies increasingly introduce computers into our surroundings. In the domestic environment, these sometimes do little more than replacing device functions that would once have been achieved mechanically. However, an increasing number of domestic appliances also offer more powerful opportunities for configuration, no longer restricted to mechanical direct manipulation, but instead programming the appliance so that it will behave differently in future. This paper investigates the possibility that gender imbalance in professional computing might extend to disempowerment of women in a domestic context where end-users program their home appliances.

A note on gender studies

The remainder of this paper describes a variety of behaviours that are presented as "stereotypically" male or female. It is important to note that these descriptions are not intended to be normative descriptions of men and women (either the way they *are*, or the way they *should be*). Indeed, many men act in ways that are stereotypically female, while many women act in ways that are stereotypically male. The motivation in describing and analyzing stereotypical behaviours is in order to identify resulting inequalities, and potentially act to correct them. In statistical terms, "stereotypically female" behaviours are more likely to be found in women, and experimental data is collected on this basis. The results should not, however, be applied indiscriminately to define the ability of individuals.

SOCIAL CONTEXT AND COGNITIVE STYLE

With Jennifer Rode and Eleanor Toye, I have investigated the social context of domestic end-user programming, finding that ordinary households own many programmable appliances, and that although specific appliances may fall into male or female domains of a household, both genders engage in programming behaviour [9,10]. If there is no gender-role obstacle to end user programming in the domestic context, it is reasonable to ask whether the gender imbalance in professional software engineering might result in a "trickle-down" of imbalance in everyday contexts of ubiquitous computing such as this domestic one. Evidence of this possibility can be seen in recent work with Beckwith, Kissinger et. al., which observed gender differences in end-user programming of spreadsheets [2]. These differences could not be directly attributed to social context (they were observed in an experimental context), but appear to be derived from cognitive styles associated with differing degrees of self-efficacy [1].

A previous proposal for gender-linked cognitive styles in learning to program was made by Turkle and Papert [11]. That work drew on Papert's philosophy of "constructionism", which emphasises learning by doing. Constructionism is derived from the cognitive development theories of Piaget, who reported that children first learn

through concrete, physical experience, and only later develop abstract and symbolic ways of learning. This natural progression from concrete to abstract understanding motivated Papert's educational programming language Logo, and also Kay's Smalltalk, designed as a component of a computer for children at Xerox PARC. Kay also believed that adults should learn this way, as in his constructionist motivation for the graphical user interface: "doing with icons makes symbols" [5].

What are the social implications of constructionism? The constructionist approach to learning is described by Papert as a kind of *bricolage*, a term used by anthropologist Claude Levi-Strauss to characterise the intellectual style of non-Western cultures. Levi-Strauss wished to emphasise the way that these cultures build social aggregates of experience, rather than the decontextualised theoretical structures typical of the West. In Turkle and Papert's work [11], bricolage is also a constructionist style of programming that creates "soft" and artistic arrangements of material rather than "hard" logical hierarchies of black boxes. They support this characterisation of adult learners from the personal experience of female students taking introductory programming classes at Harvard, who are reported to learn better when they are able to build by experimenting and adapting building-block materials.

BRICOLAGE IN THE HOME

This attitude to programming would appear highly appropriate to the domestic context. People programming home appliances do not wish to build theoretical constructs (although they certainly acquire theoretical understanding through successful performance). Indeed, home appliances do not support the design of sophisticated abstractions. Instead, appliances are used principally to achieve social and cultural ends, much as recommended for female students of programming by Turkle and Paper. Does bricolage provide an appropriate perspective for the introduction of end-user programmable ubiquitous computing into the home?

One problem with use of this term is the fact that it is already strongly associated with a particular kind of domestic activity. In informal French (outside of anthropology and cultural theory), "bricolage" is a synonym for the English "DIY", meaning the practice of amateurs, hobbyists or enthusiasts who maintain and modify their own houses. In France, this activity is certainly linked to gender. I asked a French student whether a French woman would ever engage in bricolage. She answered without hesitation: "No"!

I do not believe that this is an unfortunate linguistic accident. The kind of things that a male bricoleur or DIY-enthusiast might do around the house are often associated with hobbies rather than serious utility. Early experiments in ubiquitous computing for the home have a similar taint. It has been possible for over a decade to buy programmable home control systems that link appliances together, controlling their behaviour from programs running on a central PC. The X10 standard for home automation is a popular tool for such hobbyists. If one were to identify opportunities for end-user software engineering in the home, this would seem to be an obvious target. Indeed, I was involved in a substantial research project aimed at end-user programming for home automation of this kind [6]. The many similar international research efforts aimed at developing future "smart homes" seem to be similarly masculine in their style and objectives. If home-owners are to be allowed to control and configure their homes via end-user programming, this will be a DIY/bricoleur heaven!

To summarise, Turkle and Papert recommend bricolage as an approach to programming that may be more appropriate to females. Bricolage seems likely to become a feature of end-user programming in the home, but might be framed in a way that is predominantly masculine.

TINKERING AND BRICOLAGE

The aspects of male DIY hobbyist behaviour that are least directed toward utilitarian outcomes are sometimes described as "tinkering". In the UK, this activity stereotypically takes place in a garden shed, where a man might take refuge from the social demands of the household to fiddle with pieces of wood or dismantled engines. Classic tropes of popular technology include the "backyard inventor", who, through such tinkering, achieves creative technical innovations.

One can certainly imagine that constant experimentation with tools, materials and components, whether woodwork, machinery or end-user software engineering, would lead over time to competence and even innovation. This is a positive, craft-oriented view of tinkering as a source of skill and expertise. It is related to Levi-Strauss' original adoption of the term bricolage, not to imply amateurism (as in the modern usage), but informal traditions of learning. In the domain of programming, Ben-Ari has in fact recommended that this style of engagement with computers is the best model for end-user programmers, whom he therefore describes as bricoleurs [3].

BRICOLAGE AND GENDER

Our recent study of tinkering in a conventional end-user software engineering domain, that of spreadsheets, found that males were indeed more likely to engage in tinkering [2]. Furthermore, those females who were more willing to tinker with the spreadsheet were more likely to learn. This willingness to tinker was associated with higher self-efficacy in females. However, increased tinkering in males was not always associated with improved performance in males. In fact, the opposite was true. It seems that an alternative connotation of the word tinkering, one associated with aimless time-wasting, was more typical of male behaviour in the end-user programming domain of spreadsheets.

Which of these interpretations of bricolage is likely to be true in the end-user programming domain of domestic appliance control? Will the smart homes of the future be of interest mainly to male hobbyists attracted to ubiquitous computing as the cyberspace equivalent of the garden shed? On the basis of popular literature such as technology magazines, one would have to conclude that the answer is yes. This is certainly the suspicion of female members of my own household. I believe it is true of many others.

However our study of end-user programming in existing home appliances [9] shows that women do already engage in programming at home, but for specific utilitarian purposes. It is worth asking whether the learning advantages experienced by females in our recent study of tinkering in spreadsheet programming, and recommended by Turkle and Papert for concrete experiences of object-oriented languages, might provide a basis by which females can be empowered to control and configure new pervasive computing technologies that enter their own homes.

AN EXPERIMENT IN DOMESTIC PROGRAMMING STYLES

In a recent (unpublished) study of domestic programming, Jennifer Rode, Eleanor Toye and I compared male and female approaches to the programming of a new DVD recorder. In a previous generation of domestic technology, "programming the VCR" was notorious as an activity that demonstrated lack of personal control over home technology. We wished to investigate this phenomenon in a controlled experimental context, in order to see whether there were any gender-linked effects of cognitive style that might influence home-owners' willingness to make the "attention investment" [4] involved in a transition from direct manipulation to appliance programming.

As in the work by Beckwith et. al [2], we saw a link between attention investment and self-efficacy. Low self-efficacy will result in an over-estimate of the costs involved in a novel abstraction strategy, and an under-estimate of the likelihood of success. Our experiment therefore compared participants' estimated likelihood of success in end-user programming of the appliance with their actual success in an experimental task. This task was designed to be as closely representative as possible of domestic experience of new technology. Participants were presented with a new DVD recorder and television, made by the same manufacturer, and purchased from the appliance department of a local department store. We had connected the recorder and television to power and aerial, but gave no further instructions on their use, simply giving the participant the appliance manuals, and asking them to program recording of a television show. Participants were interviewed before and after this task, in order to measure their self-efficacy.

Full results of this study will be published in due course. For the purpose of this workshop, it appears that the general trend with regard to self-efficacy for DVD programming is the same as that noted in the study of spreadsheet programming by Beckwith et. al. Of the 24 participants in our study, the 12 women were less confident than the 12 men of their ability to complete the video programming task successfully. After the task, the confidence of the men increased, while the confidence of women decreased, as also observed in the Beckwith et. al. study. These effects were more pronounced when the task involved programming, rather than non-programming functions of the DVD recorder. Despite the drop in reported self-efficacy, the actual rates of success were equal for men and women (although more women were unsure afterwards whether they had correctly completed the task).

With regard to the consequences for attention investment decisions, women predicted that the task would take them longer than men predicted. This was true, in that average completion time was substantially longer for women. As in the experiment by Beckwith et. al., we might expect this to result from more periods of reflection by women. However the estimate by women of how long they had actually spent on the task was more than double the elapsed time (an estimate of 20 minutes, as opposed to average elapsed time of 9 minutes). Post-hoc estimates by men were that they had spent only 5 minutes on the task (actual average 4). In terms of attention investment, we would expect this biased estimate of actual attention required to perform a programming task to result in future avoidance of the task, because the attention investment would appear not to be justified. We therefore see that, in the home domain as in the spreadsheet domain, initial differences in self-efficacy lead to actual differences in programming competence.

EMPOWERMENT THROUGH ESSAYAGE

What skills do we wish to encourage, in order to establish competence in both genders to configure and control ubiquitous computing infrastructure in the domestic environment? In terms of the attention investment theory of abstraction use, we would like to assist all members of a household to make the transition from direct manipulation, to abstract specification of system behaviour. It is often the case that abstract specifications of appliance function are related to the functionality that can be controlled by direct manipulation, so the required competence is a matter of understanding direct manipulation behaviours sufficiently well to compose and modify them. This understanding of component behaviour is achieved informally, through a process of active experimentation, tinkering with the direct manipulation components, while the process of modifying and composing those components can be understood in terms of informal assembly or bricolage.

Based on our experimental findings, as well as the analysis of cultural connotations of tinkering and bricolage, it seems that these kinds of experimentation in the home are stereotypically masculine. Women are less likely to engage in either tinkering or bricolage with home appliances, and hence less likely to gain the expertise necessary to become competent end-user programmers in the home.

There are, however, other domains in which stereotypically female activity has characteristics that lead to competence in constructing abstractions. The conventional view of male dressing is that men select individual items of clothing according to immediate or functional requirements (a kind of direct manipulation) without proper consideration to the complete assemblage or "outfit". Women, in contrast, are expected to be relatively expert in the coordination of items of clothing into an outfit or ensemble. This competence is not innate, but is developed through processes of deliberate experimentation, in which a woman experimentally tries on different items of clothing that she owns, in order to design ensemble outfits for use on later occasions. This form of experimentation, leading to expertise and the construction of abstract specifications from concrete elements, seems closely related to the kind of competences that are developed by men when they tinker with mechanical components.

We have noted that skill derived from tinkering is highly dependent on self-efficacy. Lack of confidence in one's own ability does not encourage tinkering, and hence prevents sufficient familiarity for the move to abstract specification. In attention investment terms, low self-efficacy perpetuates reliance on direct manipulation. In the ubiquitous computing smart home, reliance on direct manipulation will be associated with lack of control, especially as home appliances incorporate increasing numbers of abstract specification functions [7]. Rather than submit to this perpetuation of gender-stereotyped competence in relation to technology, we might instead promote positive models of experimentation and abstract description within existing domains of female competence. Just as "bricolage" veers between social theory and mundane household gender roles in order to suggest a perhaps overly masculine model of technology use, we might recommend an alternative style of engagement based on the "séance d'essayage". This phrase offers a relatively formalized recognition of the kind of female behaviour in which items of clothing are assembled into ensemble outfits. It encourages the kind of experimentation that leads to improved conceptual understanding in that domain, and it forms the basis for future competence.

The séance d'essayage is not currently associated with the kind of masculine competencies (tinkering and bricolage) that have been related to successful end-user programming. But this does not mean that such an association is impossible. Perhaps an alternative approach to software tools, one modeled on stereotypically female competence, would offer potential for greater balance in delivering the benefits of ubiquitous computing.

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